

### Principles of Engineering (PLTW)

*Principles of Engineering* is a course that focuses on the process of applying engineering, technological, scientific and mathematical principles in the design, production, and operation of products, structures, and systems. This is a hands-on course designed to provide students interested in engineering careers to explore experiences related to specialized fields such as civil, mechanical, and materials engineering. Students will engage in research, development, planning, design, production, and project management to simulate a career in engineering. The topics of ethics and the impacts of engineering decisions are also addressed. Classroom activities are organized to allow students to work in teams and use modern technological processes, computers, CAD software, and production systems in developing and presenting solutions to engineering problems. **NOTE: Use of the PLTW Course number is limited to schools that have agreed to be part of the Project Lead the Way network and follow all training and data collection requirements.**

- DOE Code: 4814
- Recommended Grade Level: Grade 10-12
- Recommended Prerequisites: Introduction to Engineering Design
- Credits: 1 credit per semester, maximum of 2 credits
- Counts as a Directed Elective or Elective for the General, Core 40, Core 40 with Academic Honors and Core 40 with Technical Honors diplomas
- This course is aligned with postsecondary courses for Dual Credit
  - Ivy Tech
    - ADMF 115 Materials and Processes of Manufacturing

#### Dual Credit

This course provides the opportunity for dual credit for students who meet postsecondary requirements for earning dual credit and successfully complete the dual credit requirements of this course.

#### Application of Content and Multiple Hour Offerings

Intensive laboratory applications are a component of this course and may be either school based or work based or a combination of the two. Work-based learning experiences should be in a closely related industry setting. Instructors shall have a standards-based training plan for students participating in work-based learning experiences.

### Content Standards

#### Domain – Energy and Power

**Core Standard 1** Students adapt and apply energy and power concepts to develop an efficient system.

##### Standards

- POE-1.1 Categorize energy sources.
- POE-1.2 Analyze energy source processes.
- POE-1.3 Determine systems efficiency and energy use.
- POE-1.4 Identify and describe the possible types of power conversion.
- POE-1.5 Assess energy sources that can be combined to convert energy to useful forms.
- POE-1.6 Calculate circuit resistance, current, and voltage using Ohm's law.
- POE-1.7 Compare the advantages and disadvantages of parallel and series circuit design.

POE-1.8 Analyze the relationships between voltage, current, and resistance

POE-1.9 Explore ways to produce mechanical power using alternative energy.

### **Domain – Structural Analysis**

**Core Standard 2** Students interpret science and math concepts to determine the effect of stresses placed on a structure and its components.

#### **Standards**

POE-2.1 Classify different structural elements of a system.

POE-2.2 Analyze forces acting upon an object in a given situation.

POE-2.3 Illustrate the moment of inertia of structural members.

POE-2.4 Differentiate between scalar and vector

POE-2.5 Employ appropriate scalar and vector calculation to problems.

POE-2.6 Use equations of equilibrium to calculate unknown forces.

POE-2.7 Use the method of joints strategy to determine forces acting on an object.

### **Domain – Material Properties, Testing, and Structural Analysis**

**Core Standard 3** Students synthesize results of tested materials and structures to determine fitness of use.

#### **Standards**

POE-3.1 Verify non-destructive material property tests on selected common products

POE-3.2 Demonstrate calculation of product mass properties as used for properties and testing documentation.

POE-3.3 Identify and describe the manufacturing processes used to create common products.

POE-3.4 Analyze material properties used to create products.

### **Domain – Study of Motion**

**Core Standard 4** Students apply and adapt the laws of motion as they apply to principles of engineering.

#### **Standards**

POE-4.1 Demonstrate the calculation of projectile motion given parameters

POE-4.2 Examine propulsion of an object.

POE-4.3 Explain how gravity effects motion

POE-4.4 Apply the laws of motion to solutions

POE-4.5 Analyze the forces acting on a object while in motion

POE-4.6 Describe the relationships among force, mass, and changes in motion.

### **Domain – Simple Machines**

**Core Standard 5** Students evaluate simple machines to incorporate into solving a wide range of design and application problems.

#### **Standards**

POE-10.1 Adapt and apply six simple machines, their attributes, and components.

POE-10.2 Calculate mechanical advantage of different mechanisms.

POE-10.3 Design, create, and test gear, pulley, and sprocket systems.

POE-10.4 Calculate work and power in mechanical systems.

POE-10.5 Determine efficiency in a mechanical system.

POE-10.6 Measure forces and distances related to mechanisms.

### **Domain – Statistics**

**Core Standard 5** Students apply and adapt basic statistics principles as it applies to project solutions.

### **Standards**

- POE-5.1 Compare theoretical and experimental data.
- POE-5.2 Use statistics to determine theoretical outcomes.
- POE-5.3 Illustrate the use of statistics in the engineering design process.
- POE-5.4 Utilize data collection to graphically present findings.

### **Domain – Hydraulics and Pneumatics**

**Core Standard 6** Students assess hydraulic and pneumatic systems for the purpose of use as a control system component.

### **Standards**

- POE-6.1 Distinguish between hydrodynamic and hydrostatic systems.
- POE-6.2 Calculate values in a fluid power system.
- POE-6.3 Distinguish between pressure and absolute pressure.
- POE-6.4 Distinguish between temperature and absolute temperature.
- POE-6.5 Calculate values in a pneumatic system.
- POE-6.6 Distinguish between temperature and absolute temperature.
- POE-6.7 Differentiate between the characteristics of pneumatic and hydraulic systems.
- POE-6.8 Identify and explain basic components and functions of fluid power devices.

### **Domain – Control Systems**

**Core Standard 7** Students apply concepts of computer programming, logic, and fluid power to establish an automated control system.

### **Standards**

- POE-7.1 Create control system operating programs that utilize computer software.
- POE-7.2 Create system control programs that utilize flowchart logic.
- POE-7.3 Choose appropriate input and output devices based on the need of a technological system.
- POE-7.4 Differentiate between the characteristics of digital and analog devices.
- POE-7.5 Judge between open and closed loop systems in order to choose the most appropriate system for a given technological problem.
- POE-7.6 Describe applications of process control and automation systems.
- POE-7.7 Apply design concepts to problems in process control and automations systems

### **Domain – Project Management**

**Core Standard 8** Students manage information and data to provide better productivity and documentation.

### **Standards**

- POE-8.1 Brainstorm and sketch possible solutions to an existing design problem.
- POE-8.2 Create a decision making matrix for design problems.
- POE-8.3 Select an approach that meets or satisfies the constraints provided in a design brief.
- POE-8.4 Create a detailed pictorial sketch and use 3D modeling software to document the best choice.
- POE-8.5 Present a workable solution to the design problem.
- POE-8.6 Document daily work and progress toward a solution in an engineering notebook.

### **Domain – Careers**

**Core Standard 9** Students assess the education, training, and certification needed for careers in engineering and engineering technology for potential career choices.

### **Standards**

- POE-10.1 Conduct research on the current and future outlook for engineering and engineering technology careers.
- POE-10.2 Research college/technical schools for class requirements for entering engineering and engineering technology career majors.
- POE-10.3 Identify and describe different engineering disciplines.

## Process Standards

### Common Core Literacy Standards for Technical Subjects

#### Reading Standards for Literacy in Technical Subjects 9-10

The standards below begin at grade 9 and define what students should understand and be able to do by the end of grade 10. The CCR anchor standards and high school standards in literacy work in tandem to define college and career readiness expectations – the former providing broad standards, the latter providing additional specificity.

#### Key Ideas and Details

- 9-10.RT.1 Cite specific textual evidence to support analysis of technical texts, attending to the precise details of explanations or descriptions.
- 9-10.RT.2 Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.
- 9-10.RT.3 Follow precisely a complex multistep procedure when performing technical tasks, attending to special cases or exceptions defined in the text.

#### Craft and Structure

- 9-10.RT.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific context relevant to *grades 9-10 texts and topics*.
- 9-10.RT.5 Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., *force, friction, reaction force, energy*).
- 9-10.RT.6 Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.

#### Integration of Knowledge and Idea

- 9-10.RT.7 Translate technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
- 9-10.RT.8 Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a technical problem.
- 9-10.RT.9 Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

#### Range of Reading and Level of Text Complexity

- 9-10.RT.10 By the end of grade 10, read and comprehend technical texts in the grades 9-10 text complexity band independently and proficiently

#### Writing Standards for Literacy in Technical Subjects 9-10

The standards below begin at grade 9 and define what students should understand and be able to do by the end of grade 10. The CCR anchor standards and high school standards in literacy work in tandem to

define college and career readiness expectations – the former providing broad standards, the latter providing additional specificity.

### **Text Types and Purposes**

- 9-10.WT.1 Write arguments focused on *discipline-specific content*.
- 9-10.WT.2 Write informative/explanatory texts, including technical processes.
- 9-10.WT.3 Students will not write narratives in technical subjects. *Note: Students' narrative skills continue to grow in these grades. The Standards require that students be able to incorporate narrative elements effectively into arguments and informative/explanatory texts. In technical, students must be able to write precise enough descriptions of the step-by-step procedures they use in their technical work that others can replicate them and (possibly) reach the same results.*

### **Production and Distribution of Writing**

- 9-10.WT.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
- 9-10.WT.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
- 9-10.WT.6 Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

### **Research to Build and Present Knowledge**

- 9-10.WT.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
- 9-10.WT.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectivity to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation
- 9-10.WT.9 Draw evidence from informational texts to support analysis, reflection, and research.

### **Range of Writing**

- 9-10.WT.10 Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.